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REPRODUCTIVE ECOLOGY AND HABITAT UTILIZATION  
OF RICHARDSON'S MERLINS IN SOUTHEASTERN MONTANA

By

Dale M. Becker

B.S., University of Montana, 1980

Presented in partial fulfillment of the requirements for the degree of

Master of Science

UNIVERSITY OF MONTANA

1984

Approved by:



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## ABSTRACT

Becker, Dale M.

Wildlife Biology

Reproductive Ecology and Habitat Utilization of Richardson's Merlins in Southeastern Montana (62 pp.)

Director: I. J. Ball *ggb*

Reproductive ecology, food habits, habitat utilization, and eggshell quality of Richardson's Merlins (Falco columbarius richardsonii) in southeastern Montana were examined. Breeding activity spanned five months. Clutch size, brood size, and fledging success at active nests were similar ( $P \geq 0.05$ ) among four years. Birds comprised  $>90\%$  of individual prey items, and 61% of avian prey species were typically associated with predominantly open habitats. Horned Larks (Eremophila alpestris), Lark Buntings (Calamospiza melanocorys), and Vesper Sparrows (Pooecetes gramineus) collectively comprised 57% of all prey. Home ranges of three breeding male Merlins encompassed approximately 13, 23 and 28 km<sup>2</sup>, and each male traveled a maximum of 8 to 9 km from his nest. These home ranges encompassed five physiognomic habitat types. Percentages of total observations by habitat type indicated greatest use of sagebrush and grassland habitats. Sagebrush, riparian, and ponderosa pine habitats were used more ( $P \leq 0.05$ ) than expected, but grassland and agriculture habitats received less ( $P \leq 0.05$ ) use than expected. Comparisons of Montana eggshells with pre-pesticide (pre-1946) eggshells indicated 12% and 20% reductions in eggshell weight and eggshell thickness indices, respectively. These reductions were significant ( $P \leq 0.01$ ). Seven organochlorine compounds were detected in eggs collected on the study area. The overall management goal should be maintenance of a viable Merlin population and the habitat features essential for its continued existence. Management recommendations include limitation of alteration of ponderosa pine sideslope habitat, restriction of activities from 10 March through 20 July, rescheduling of activities, establishment of 400 m zones of no disturbance surrounding nests, limiting loss of prairie habitat and sagebrush removal, limiting use of organochlorine compounds, reviewing potential impacts of activities prior to their occurrence, and maintaining confidentiality of nest locations.

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used in food habits studies. Drs. D.R. Jenni and C.J. Jonkel provided telemetry equipment used in home range studies.

Analyses of Merlin eggs for pesticide residues was conducted by Dr. O.H. Pattee (Patuxent Wildlife Research Center). Information on Merlin egg sets in natural history museums was provided through the courtesy of Dr. G.D. Alcorn (University of Puget Sound Museum of Natural History), C. Chase (Denver Museum of Natural History), J. Hinshaw (University of Michigan Museum of Zoology), L.F. Kiff and S. Sumida (Western Foundation of Vertebrate Zoology), N. Kracunas (Milwaukee Public Museum), Dr. R.A. Paynter, Jr. (Harvard Museum of Comparative Zoology), and W.D. Vanko (National Museum of Natural History).

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## CHAPTER I

### INTRODUCTION

The Merlin or Pigeon Hawk (Falco columbarius) is a small falcon that occurs over a large portion of the Northern Hemisphere. Eight subspecies are recognized throughout the world, and three of these breed in North America (Brown and Amadon 1968). The Taiga Merlin (F. c. columbarius) breeds in the Boreal Forest of Alaska, Canada, and the northern United States. Breeding range of the Black Merlin (F. c. suckleyi) extends from the humid Pacific coastal forests of southeastern Alaska southward to southwestern British Columbia and possibly into northwestern Washington. The Richardson's Merlin (F. c. richardsonii), the subspecies of interest in this study, breeds in the prairie parklands of the northern Great Plains in Canada and the United States (Temple 1972a).

To date, most ecological studies of North American Merlins have been conducted on Richardson's Merlins inhabiting the Canadian prairie provinces. Breeding biology, migration, wintering habits, and food habits of a population of Richardson's Merlins in Saskatchewan were documented by Fox (1964). Oliphant (1974) discussed breeding chronology, behavior, and food habits of an urban population in Saskatoon, and has continued to study the status of this population. Breeding ecology, habitat utilization, food habits, and limiting factors were subjects of research in Alberta (Hodson 1976). Food caching

and prey utilized by Richardson's Merlins in Saskatoon were documented by Oliphant and Thompson (1977) and Oliphant and McTaggart (1977), respectively.

The second major type of research on Richardson's Merlins dealt with the apparent effects of organochlorine residues on reproductive success. Fox (1971) documented declines in eggshell weight, hatching success, and production of young Merlins in Canada. In Alberta, Hodson (1976) hypothesized that expanded cultivation of shortgrass prairie, coupled with the accumulation of organochlorine residues in Merlins, were primary causes of population declines. Behavioral abnormalities resulting from elevated organochlorine residue levels in Canadian Merlins were reported by Fyfe et al. (1976). Oliphant and Thompson (1978) summarized recent breeding success of Richardson's Merlins in Saskatchewan and concluded that earlier concerns about the status of this subspecies, such as those expressed by Trimble (1975), may have been unwarranted. Finally, Fox and Donald (1980) observed that Merlins with higher dichlorodiphenyldichloroethylene (DDE) residues exhibited lower eggshell quality, greater loss of eggs, and lower hatching frequency than Merlins with lower levels of pesticide residues.

Research on Richardson's Merlins in the United States has been quite limited. Ellis (1976) discussed nesting habitat and reproductive success of Merlins in western and central Montana. Other documentation has dealt primarily with local accounts (Stewart 1975, Craig and Renn 1977, Call 1978).

Effective management of this species and its habitat requires data on reproductive parameters, food habits, habitat utilization, and potential limiting factors. This study was conducted in southeastern Montana to collect data on these factors and others for a population of Richardson's Merlins. Objectives of the study were to:

- 1) locate active nests, determine timing and duration of breeding activities, and assess reproductive success;
- 2) determine food habits;
- 3) determine the use of various habitat types;
- 4) assess the effects of chemical pollutants, specifically organochlorine pesticides, on eggshell quality and reproductive success; and,
- 5) recommend management actions which will benefit Merlins and their habitat on the study area.

This thesis consists of five manuscripts which will be submitted for publication. Each manuscript appears in the thesis as an individual chapter. The final chapter contains management recommendations based on the results of the study.

## CHAPTER II

### EARLY NESTING RECORDS FOR MERLINS IN MONTANA AND NORTH DAKOTA

A questionnaire regarding Merlin (Falco columbarius) eggs sent to several natural history museums in North America revealed a number of previously unreported sets collected in Montana and North Dakota. The first breeding records for the Merlin in Montana were recently reported by Ellis (1976). However, three egg sets collected in Montana pre-dated Ellis' (1976) report. R.B. Hitz collected two eggs near Sun River on 5 July 1867 (National Museum of Natural History, USNM 13478). Two eggs were collected near Helena on 26 May 1882 by A.H. Palmer (Milwaukee Public Museum, MPM 417). The third set, consisting of four eggs collected in Dawson County on 11 May 1895, was collected by C.A. Thurston (Harvard University Museum of Comparative Zoology, MCZ 4285).

Several early nesting records for Merlins in North Dakota were reported by Stewart (1975). Additional nesting records for North Dakota include sets of four and five eggs collected in Stark County by R. Dodd on 23 May 1897 and 25 May 1900, respectively (Western Foundation of Vertebrate Zoology, WFUZ 1077684 and 79652-5). A third set was collected on 13 May 1924 near Columbus by an unknown collector (University of Michigan Museum of Zoology, UMMZ 190898).

Museum records provide useful historical information on nesting

Merlins in the United States, and can add to our knowledge of the species occurrence in particular areas where documented observations or specimens are lacking.



## CHAPTER III

### BREEDING CHRONOLOGY AND REPRODUCTIVE SUCCESS OF RICHARDSON'S MERLINS IN SOUTHEASTERN MONTANA

The Merlin (Falco columbarius) is one of six species of falcons that occur in North America. Three subspecies of North American Merlins are recognized (Temple 1972a). The Richardson's Merlin (F. c. richardsonii) occurs in the prairie-parklands of the northern Great Plains.

Data pertaining to the ecology of Richardson's Merlins have been generated primarily from studies in the prairie provinces of Canada. The life history of Canadian Merlins, including breeding chronology and reproductive success, was documented by Fox (1964, 1971). In Alberta and Saskatchewan, Hodson (1976) reported that reproductive success at Merlin nests that fledged young was high, but net productivity was variable. An apparent increase in reproductive success over that reported by previous studies was discussed for Merlins in Saskatchewan by Oliphant and Thompson (1978).

Information on Richardson's Merlins in the United States is lacking, although local populations or scattered breeding pairs occur in several western states (Oliphant, In press). This study was initiated to document the reproductive ecology of a population of Richardson's Merlins in Montana.

## Study Area

Breeding chronology and reproductive success of Richardson's Merlins were examined on a 39,448 ha study area in southeastern Montana. Sandstone buttes and hills ranging to 300 m above the adjacent prairies and farmlands were common on the study area. Maximum elevation was 1,282 m above sea level. Vegetation consisted of approximately 27% forest cover and 67% grassland. The dominant forest species was ponderosa pine (Pinus ponderosa). Aspen (Populus tremuloides), box elder (Acer negundo), green ash (Fraxinus pennsylvanica), and a variety of shrubs grew in more mesic sites. Major grassland species were western wheatgrass (Agropyron smithii), blue grama (Bouteloua gracilis), prairie junegrass (Koeleria cristata), and needle-and-thread grass (Stipa comata). Agriculture was the major land use. Livestock grazing occurred throughout the study area, and wheat, oats, barley, and alfalfa were the most important crops.

The climate in southeastern Montana was characterized by frequent winds, hot summers, cold winters, and a semi-arid moisture regime. Annual precipitation averaged 39 cm, of which 70% fell from May through September. Monthly mean temperatures during the Merlin breeding season ranged from -8°C in March to 33°C in July.

## Methods

Breeding chronology and reproductive success of Richardson's Merlins were studied from March through September of 1978-1981. Breeding territories were located by traversing potential nesting habitat (i.e., ponderosa pine stands) during April and May. Nest sites were detected when adults were flushed or exhibited aerial and vocal defense behavior. When flushing was not observed but defensive adult Merlins were present, Black-billed Magpie (Pica pica) nests in the vicinity were examined.

Timing and duration of breeding activities were determined by observing Merlins from early spring through early autumn. Observations of courtship, hatching, growth of young, fledging, and dispersal were documented at active nests. Numbers of eggs, young, and fledglings were recorded during three visits to each nest: during incubation, shortly after hatching, and just prior to fledging. Precautions were taken to avoid undue disturbance of adults and young (Fyfe and Olendorff 1976).

Data collected during nest visits were used to calculate percentages of eggs hatched, young fledged, and eggs resulting in fledglings. Fledging success was calculated for active nests ("nests in which eggs have been laid") and successful nests ("occupied nests from which at least one young fledged during the breeding season under consideration") (Postupalsky 1974). Sex of nestlings was determined at approximately two weeks of age. Larger foot size and

larger, less fully developed bodies (Fox 1964), along with greater tarsal diameter were generally reliable characteristics of females.

Student t-tests were used to compare reproductive success among years. Paired t-tests were used to compare average clutch size, brood size, and number of fledglings per active nest within years. Clutch size, brood size, and number of fledglings per active nest for the four years combined were compared using a combination of probabilities from tests of significance (Fisher 1950). Unless otherwise noted, differences were considered significant at  $\alpha = 0.05$ .

## Results

### Breeding Chronology

The earliest observation of an adult Merlin on the study area was 11 March 1978. Breeding activities spanned approximately five months from the earliest observation of an adult until the latest dispersal of adults and young (Figure 1).

Males were observed at breeding territories before females. Courtship began shortly after the arrival of the females in early April and continued through May (Figure 1). Eggs were laid from mid-April through late May. Females usually incubated eggs, although males were occasionally observed on nests for short periods.

Earliest observed hatching occurred on 24 May 1980, and the latest on 27 June 1979. Nestlings were brooded from three to five

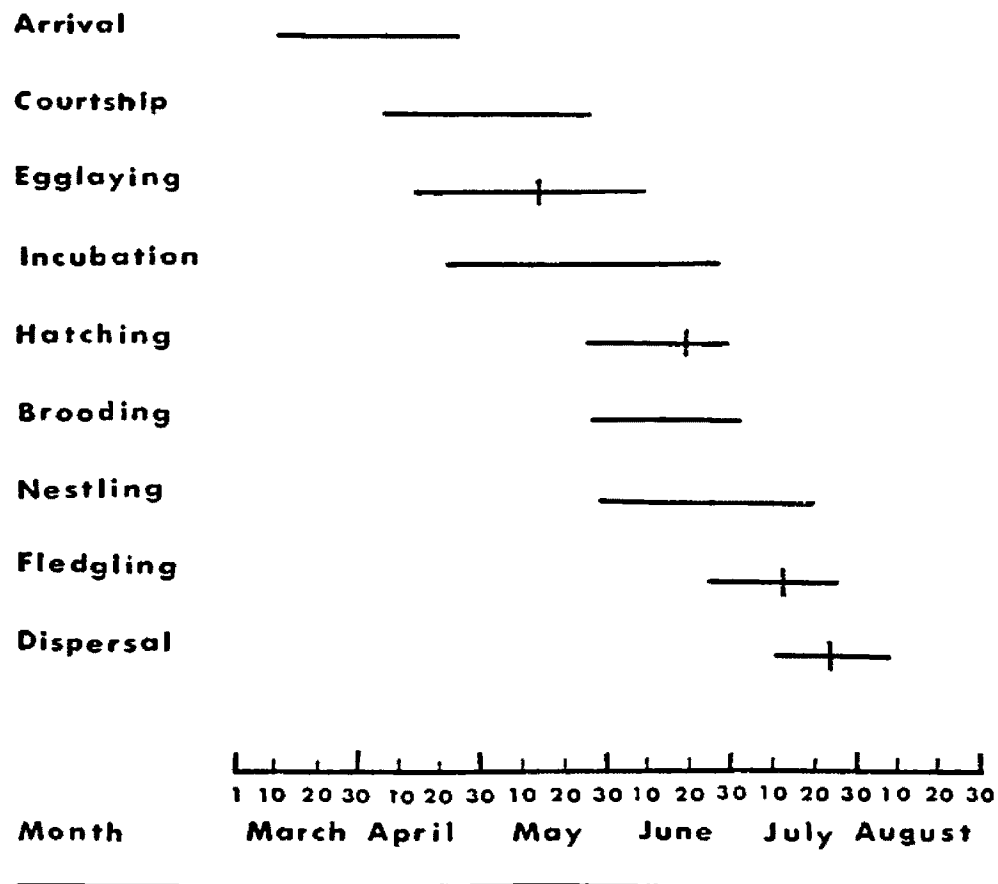


Figure 1. Breeding chronology of Richardson's Merlins in southeastern Montana. Horizontal lines indicate ranges of activity, vertical lines indicate means.

days, and remained in the nest for 12 to 17 days before beginning to spend time on top of the nest canopy and/or in nearby branches. Young Merlins fledged from 26 to 33 ( $\bar{x} = 29$ ) days after hatching. Fledging dates ranged from 24 June to 18 July. Fledglings remained in the vicinity of the nest from 7 to 19 ( $\bar{x} = 13$ ) days after fledging. The latest dispersal of young and adults from a breeding territory occurred on 9 August 1979.

### Reproductive Success

Forty-eight active Merlin nests were located during the study, of which 43 (90%) were ultimately successful in producing fledglings. All nests were originally Black-Billed Magpie nests located in ponderosa pine trees on sideslopes of buttes.

The number of eggs laid per nest did not vary significantly from year to year during this study (Table 1). Brood sizes were also similar among years. Sex ratios of 157 nestlings indicated a slightly greater proportion of females (53%) than males (47%). Numbers of fledglings per active nest did not differ significantly among years.

In three of the four years, and for the four years combined, significant mortality was observed from the time the eggs were laid until the Merlins fledged (Table 1). Average clutch size differed significantly from average brood size in 1978, 1979, and 1980, while clutch size was similar to brood size in 1981. Average number of fledglings per active nest was smaller ( $P \leq 0.08$ ) than average brood

Table 1. Reproductive success of Richardson's Merlins in southeastern Montana, 1978-1981.

Year	Sample Size	Clutch Size ( $\bar{X} \pm SE$ ) <sup>1</sup>	Brood Size ( $\bar{X} \pm SE$ )	Fledgling/ Active Nest ( $\bar{X} \pm SE$ )	Eggs Hatched (%)	Young Fledged (%)	Eggs Resulting in Fledglings (%)
1978	8	4.1 $\pm$ 0.2 <sup>a</sup>	3.3 $\pm$ 0.4 <sup>b</sup>	3.0 $\pm$ 0.6 <sup>b</sup>	79	92	73
1979	18	4.3 $\pm$ 0.2 <sup>a</sup>	3.6 $\pm$ 0.4 <sup>b</sup>	3.3 $\pm$ 0.4 <sup>c*</sup>	84	92	78
1980	15	4.5 $\pm$ 0.2 <sup>a</sup>	3.5 $\pm$ 0.4 <sup>b</sup>	3.3 $\pm$ 0.4 <sup>c</sup>	79	94	75
1981	7	4.3 $\pm$ 0.4 <sup>a</sup>	4.3 $\pm$ 0.4 <sup>a</sup>	3.3 $\pm$ 0.9 <sup>a</sup>	100	77	77
Combined data	48	4.3 $\pm$ 0.8 <sup>a</sup>	3.6 $\pm$ 1.4 <sup>b</sup>	3.3 $\pm$ 1.6 <sup>c</sup>	84	90	76

<sup>1</sup> Mean  $\pm$  standard error.

a, b, c, Means within rows (clutch size, brood size, fledglings per active nest) with the same superscript are not significantly different ( $P \geq 0.05$ ).

\* In 1979, fledglings/active nest was smaller than brood size at  $\alpha \leq 0.08$ .

size in 1979. In 1978 and 1981, the number of fledglings per active nest did not differ significantly from average brood size. For the four years combined, clutch size, brood size, and number of fledglings per active nest were different.

## Discussion

### Breeding Chronology

The presence of male Merlins in early March when the study area was first visited indicated that some males had arrived earlier, or possibly over-wintered in the area. Male Richardson's Merlins in Saskatchewan arrived at breeding sites as early as late February or early March, up to a month before females (Fox 1964).

The chronology of Merlin breeding activities in southeastern Montana was similar to breeding chronology of captive Richardson's Merlins in Alberta (Campbell and Nelson 1975) and wild Merlins in Saskatchewan (Fox 1964, Oliphant 1974) and Alberta (Hodson 1976). However, some breeding activities began earlier in the spring in Montana than in Canada. As an example, the peak egg-laying date in Saskatchewan was 20 May (Fox 1964), but Merlins in Montana had generally completed laying by this date.



## Reproductive Success

Reproductive success of Richardson's Merlins remained relatively consistent throughout the study, as evidenced by the low year-to-year variability of clutch size, brood size, and number of fledglings per successful nest. Average clutch size, brood size, and number of fledglings per successful nest for the four years combined were similar to results reported by Fox (1964, 1971), Fox and Donald (1980), and Oliphant and Thompson (1978) (Table 2). Average clutch and brood sizes for the Montana study were near the upper range of values reported by these authors, and although fledging data from other studies are limited, the average number of fledglings in this study was generally higher.

Percentages of eggs which hatched and resulted in fledglings in southeastern Montana were within the range of values reported by other authors. The hatching success rate of the Montana Merlins was higher than the 60% and 58% hatching rates reported by Fox (1964) and Hodson (1976), respectively, but 96% fledged in Saskatchewan (Fox 1964). The percentage of nestlings which fledged during this study was within this range.

Mortality tended to be highest prior to hatching for the Montana Merlins, as evidenced by the significant loss of eggs before the nestling stage. However, post-hatching mortality was common during each year, and for the four years combined resulted in a significant loss of Merlins between hatching and fledging. Causes of mortality in

Table 2. Reproductive success of Richardson's Merlins in various areas in the northern Great Plains of the United States and Canada (sample sizes in parentheses).

Study	Location	$\bar{X}$ Clutch Size	$\bar{X}$ Brood Size	$\bar{X}$ Fledglings/ Successful Nest
Fox, 1964	Saskatchewan	4.5 (10)	2.7 (10)	---
Fox, 1971	Great Plains (forested)	4.1 (9)	4.0 (16)	---
Fox, 1971	Great Plains (prairie)	4.5 (10)	2.7 (17)	2.8 (6)
Hodson, 1976	Alberta and Saskatchewan	4.6 (156)	3.5 (107)	3.2 (108)
Oliphant and Thompson, 1978	Saskatchewan	---	---	4.0 (47)
Fox and Donald, 1980	Alberta	4.1 (10)	3.7 (10)	---
Fox and Donald, 1980	Alberta	3.4 (10)	1.9 (10)	---
This Study	Montana	4.3 (48)	3.6 (48)	3.7 (43)

this study were not specifically identified, but may have included predation on eggs and nestlings, as well as inclement weather at hatching time. Cold, rainy weather in Alberta during the hatching stage of Richardson's Merlins resulted in severe losses of active nests (Hodson 1976). Human disturbance did not appear to be a major cause of nest failures. Precautions were taken by study personnel to minimize disturbance of breeding Merlins and nestlings, and the isolation of most nests made harassment from other human activities unlikely.

Results of this study indicate that the initiation and duration of breeding activities of Richardson's Merlins in southeastern Montana were similar to those reported for Merlins in Canada, although breeding activities appeared to begin earlier in the spring. Reproductive success rates for Richardson's Merlins in southeastern Montana were generally higher and more consistent among years when compared to other studies. Mortality was highest before hatching, followed by the period between hatching and fledging. Although human disturbance from research activities did not appear to be a cause of mortality, extensive human activities such as energy and mineral exploration and development or more intensive agricultural practices may disrupt breeding activities.

## CHAPTER IV

### FOOD HABITS OF RICHARDSON'S MERLINS IN SOUTHEASTERN MONTANA

#### Introduction

Early information on food habits of Merlins (Falco columbarius) was derived primarily from examination of stomach and crop contents (Fisher 1893, Bent 1938) and from observation of hunting and feeding activities (Craighead and Craighead 1940, Lawrence 1949). Regurgitated pellets were examined by Breckenridge and Errington (1938) and Johnson and Coble (1967) to determine food habits of Merlins in the northcentral United States. More recently, food habits of breeding Merlins have been examined and quantified by analyses of prey remains gathered at or near active nests in Canada (Fox 1964, Oliphant and McTaggart 1977, Hodson 1978) and in Europe (Sperber and Sperber 1963, Newton et al. 1978, Watson 1979).

Little is known about the food habits of Merlins breeding in the western United States. As part of an ecological study of Richardson's Merlins (F. c. richardsonii) breeding in southeastern Montana, food habits were examined during May through July of 1980 and 1981.

## Study Area

Data on food habits of Richardson's Merlins were collected on three separate areas of southeastern Montana. Each area consisted of hills and sandstone buttes ranging to approximately 300m above the adjacent prairies and farmlands. Grassland composed approximately 67% of the study area, and 27% was dominated by forest cover. Ponderosa pine (Pinus ponderosa) was the major forest species. Aspen (Populus tremuloides), box elder (Acer negundo), and green ash (Fraxinus pennsylvanica) grew in more mesic locations. Primary grassland species included blue grama (Bouteloua gracilis), western wheatgrass (Agropyron smithii), and needle-and-thread grass (Stipa comata). Dominant shrubs were big sagebrush (Artemisia tridentata), silver sagebrush (A. cana), and snowberry (Symphoricarpos albus).

## Methods

During May through July of 1980 and 1981, prey remains (contour feathers, wings, legs, beaks, etc.) and regurgitated pellets were collected at or near 20 active Richardson's Merlin nests. Each nest was visited at least three times, and all prey remains present at the nest site or at nearby perches were removed and cataloged for later identification. Prey remains were individually examined and identified to species when possible. When piles of feathers and other remains were located, primary feathers were counted individually. If

less than 10 primaries of a left or a right wing were present, it was assumed that one individual bird had been consumed. When more than 10 primaries from a left or a right wing were located, these were counted and divided by 10 to provide the minimum number of prey individuals involved. Pellets were individually soaked in water and examined under a variable power dissection microscope. Bird and reptile remains were identified by comparison with museum specimens. Mammal skull remains were identified by skull characteristics (Hoffman and Pattie 1968). Mammal hair samples were identified by dorsal guard hair characteristics (Moore et al. 1974). Insect remains were identified by comparison with specimens collected in the field.

Correlation of relative composition of prey during 1980 and 1981 was calculated by Spearman's rho (Harnett 1970). Significance of the correlation was tested at the 0.05 level of significance.

## Results

A total of 1,951 individual prey remains (flight feathers, wings, legs, beaks, etc.) and 110 pellets were collected from nests and perches during 88 visits to nest sites. These items represented at least 427 individual prey, 173 in 1980 and 254 in 1981 (Table 3).

Birds comprised over 90% of total prey in both 1980 and 1981, and accounted for an average of 92% of all prey (Table 3). Seventeen (61%) of 28 species of birds identified as prey were species typically associated with grasslands or predominantly open prairie

Table 3. Food habits of Richardson's Merlins in southeastern Montana, 1980 and 1981.

	1980			1981			COMBINED DATA		
	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*
<u>Birds</u>									
Horned Lark ( <u>Eremophila</u> <u>alpestris</u> )	48	27.7	84.4	68	26.8	79.1	116	27.2	81.8
Lark Bunting ( <u>Calamospiza</u> <u>melanacorys</u> )	26	15.0	42.2	49	19.3	79.1	75	17.6	60.2
Vesper Sparrow ( <u>Pooecetes</u> <u>gramineus</u> )	9	5.2	15.6	45	17.7	70.6	54	12.7	35.2
Mountain Bluebird ( <u>Sialia</u> <u>currocoides</u> )	16	9.2	20.0	12	4.7	16.3	28	6.6	18.2
Western Meadowlark ( <u>Sturnella</u> <u>neglecta</u> )	7	4.0	15.6	11	4.3	14.0	18	4.4	14.8
Chestnut-collared Longspur ( <u>Calcarius ornatus</u> )	6	3.5	11.1	10	3.9	4.6	16	3.8	7.9
Red Crossbill ( <u>Loxia</u> <u>curvirostra</u> )	8	4.6	11.1	5	2.0	4.6	13	3.0	7.9
American Goldfinch ( <u>Carduelis</u> <u>tristis</u> )	3	1.7	6.7	6	2.4	11.6	9	2.1	9.1
Chipping Sparrow ( <u>Spizella</u> <u>passerina</u> )	5	2.9	6.7	2	0.8	4.6	7	1.6	5.7
Killdeer ( <u>Charadrius</u> <u>vociferus</u> )	6	3.5	11.1	1	0.4	2.3	7	1.6	6.8

Table 3. continued

	1980			1981			COMBINED DATA		
	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*
<u>Birds</u>									
Bobolink ( <u>Dolichonyx</u> <u>oryzivorus</u> )	2	1.2	4.4	3	1.2	7.0	5	1.2	5.7
Brown-headed Cowbird ( <u>Molothrus ater</u> )	1	0.6	2.2	4	1.6	7.0	5	1.2	4.5
Brewer's Sparrow ( <u>Spizella</u> <u>breweri</u> )	3	1.7	6.7	2	0.8	4.6	5	1.2	5.7
Brewer's Blackbird ( <u>Euphagus</u> <u>cyanocephalus</u> )	1	0.6	2.2	4	1.6	7.0	5	1.2	4.5
Lark Sparrow ( <u>Chondestes</u> <u>grammacus</u> )	3	1.7	6.7	1	0.4	2.3	4	0.9	4.5
Townsend's Solitaire ( <u>Myadestes townsendi</u> )	2	1.2	4.4	2	0.8	4.6	4	0.9	4.5
House Sparrow ( <u>Passer</u> <u>domesticus</u> )	1	0.6	2.2	1	0.4	2.3	2	0.5	2.3
Poor will ( <u>Phalaenoptilus</u> <u>nuttallii</u> )	2	1.2	4.4	0	0.0	0.0	2	0.5	2.3
Red-winged Blackbird ( <u>Agelaius phoeniceus</u> )	2	1.2	4.4	0	0.0	0.0	2	0.5	2.3
American Robin ( <u>Turdus</u> <u>migratorius</u> )	1	0.6	2.2	1	0.4	2.3	2	0.5	1.1



Table 3. continued

	1980			1981			COMBINED DATA		
	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*
<u>Birds</u>									
Cliff Swallow ( <u>Petrochelidon</u> <u>pyrrhonata</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Eastern Kingbird ( <u>Tyrannus</u> <u>tyrannus</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Savannah Sparrow ( <u>Passerculus</u> <u>sandwichensis</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Dark-eyed Junco ( <u>Junco</u> <u>hyemalis</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Say's Phoebe ( <u>Sayornis</u> <u>saya</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Northern Oriole ( <u>Icterus</u> <u>galbula</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Mourning Dove ( <u>Zenaida</u> <u>macroura</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Yellow-rumped Warbler ( <u>Dendroica coronata</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Unidentified Bird	1	0.6	2.2	5	2.0	11.6	6	1.4	6.8
Sub-totals	161	93.3		232	91.5		393	92.2	

Table 3. concluded

	1980			1981			COMBINED DATA		
	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*	# of Indiv	% Total	% Freq*
<u>Insects</u>									
Grasshopper (Family Acrididae)	6	3.5	11.1	11	4.3	11.6	17	4.0	11.4
Moth (Family Noctuidae)	2	1.2	4.4	3	1.2	7.0	5	1.2	5.7
Sub-totals	8	4.7		14	5.5		22	5.2	
<u>Mammals</u>									
Thirteen-lined Ground Squirrel ( <u>Spermophilus</u> <u>tridecemlineatus</u> )	1	0.6	2.2	7	2.8	16.3	8	1.9	9.1
Myotis Bat ( <u>Myotis</u> spp.)	2	1.2	4.4	0	0.0	0.0	2	0.5	2.3
Least Chipmunk ( <u>Eutamias</u> <u>minimus</u> )	1	0.6	2.2	0	0.0	0.0	1	0.2	1.1
Sub-totals	4	2.4		7	2.8		11	2.6	
<u>Reptiles</u>									
Northern Short- horned Lizard ( <u>Phrynosoma</u> <u>douglassi</u> <u>brevirostre</u> )	0	0.0	0.0	1	0.4	2.3	1	0.2	1.1
Sub-totals	0	0.0		1	0.4		1	0.2	
TOTALS	173	100.4		254	100.2		427	100.2	

\* % frequency denotes the percentage of 88 prey collection visits at which the particular prey species was present.

habitats. These species collectively comprised 83% of the total number of individual prey recorded. Horned Larks (Eremophila alpestris), Lark Buntings (Calamospiza melanocorys), and Vesper Sparrows (Poocetes gramineus) collectively comprised 48% of individual prey quantified in 1980 and 64% in 1981. These three species accounted for 57% of the total prey during both years. In addition, remains of these species were generally recorded with greater frequency during prey collection visits than other species.

Seven prey species were birds typically associated with forested habitat. These species represented 7% of the total prey during both years.

The only insects recorded as Merlin prey were grasshoppers (Family Acrididae) and moths (Family Noctuidae). These insects collectively comprised 5% of the total prey (Table 3). Mammals accounted for approximately 3% of the total prey. Thirteen-lined ground squirrels (Spermophilus tridecemlineatus) were the mammal species most often recorded as Merlin prey. The only reptile recorded was one northern short-horned lizard (Phrynosoma douglassi brevirostre).

There was a significant positive correlation between relative prey composition during 1980 and 1981 ( $r_s = 0.62$ ,  $P \leq 0.05$ ). Although the number of species recorded as Merlin prey differed between 1980 and 1981 (33 vs. 23 species), the relative composition of prey species was similar.

## Discussion

The results of this study illustrate the importance of grassland/prairie avifauna as the major component of prey utilized by breeding Richardson's Merlins in southeastern Montana. Similar results have been observed in studies of food habits of Merlins breeding in the Canadian prairies. Fox (1964) observed that about 54% of the prey items recorded on his study area in Saskatchewan were Horned Larks, 14% were Chestnut-collared Longspurs (Calcarius ornatus), and 13% were Brown-headed Cowbirds (Molothrus ater). Vesper Sparrows, Song Sparrows (Melospiza melodia), and Baird's Sparrows (Ammodramus bairdii) each comprised slightly less than 7% of the total prey. Hodson (1978) noted that 50% of prey items collected in Alberta consisted of Horned Lark remains, and 37% consisted of Chestnut-collared Longspur remains. In a study of prey utilization by Merlins breeding in an urban setting in Saskatoon, Saskatchewan, Oliphant and McTaggart (1977) reported that approximately 64% of 176 identified prey items consisted of House Sparrows (Passer domesticus), 8% unidentified sparrow-sized birds, 6% Horned Larks, and a variety of other birds.

Hodson (1978) hypothesized that Horned Larks and Chestnut-collared Longspurs were heavily utilized as prey by breeding Richardson's Merlins in Alberta because their methods of feeding were more noticeable than those of other grassland birds. Oliphant and McTaggart (1977) suggested that Merlins breeding in

urban Saskatoon captured a large number of House Sparrows because this species was abundant at a given time.

Observations of hunting habitat use from radio-telemetry studies of breeding male Richardson's Merlins on the Montana study area indicated that the birds hunted most often in open prairie and grassland habitats. Horned Larks, Lark Buntings, and Vesper Sparrows were the most conspicuous species, and apparently the most abundant in these habitats. Thus, the prey species used by Richardson's Merlins in the Montana population may have been a result of how easily they were observed by hunting Merlins as well as how abundant they were.

The importance of open grassland/prairie habitats as hunting habitat for Richardson's Merlins breeding in southeastern Montana is evident from prey composition. Females generally remained in the vicinity of their nests during the nestling period while males did most of the hunting. Consequently, some of the forest species taken as prey may have been captured routinely by female Merlins tending their broods. Attempts to manage hunting habitat of Merlins should address the importance of prairie grasslands and shrublands. Under the assumption that prey species heavily utilized by Merlins are key elements in determining the well-being of this population, it would be desirable to maintain as much grassland/prairie habitat as possible. Livestock grazing has been a factor in creating the present condition of vegetation on the study area. Some disturbance of vegetation such as that associated with grazing might be expected to benefit certain

bird species while being detrimental to others. Higher breeding densities of Horned Larks have been recorded on heavily-grazed Colorado rangeland than on lightly-grazed areas, but breeding densities of Lark Buntings were higher on areas subjected to less grazing pressure (Ryder 1980). Hodson (1978) suggested that birds in grazed areas in Alberta may have been more susceptible to predation by Merlins due to limited escape cover in such areas.

Increased dryland farming on the study area could result in a decline in numbers of breeding Merlins, depending upon the degree of conversion of grassland/prairie habitat to cropland. Although Horned Lark densities on fallow cultivated lands in an Alberta study were relatively higher (Owens and Myres 1973), densities of other species were very low. Horned Larks represented a large proportion of Merlin prey documented in this study; however, the use of a variety of species is also of interest because it reflects flexibility in food habits. The degree of flexibility that Merlins could exhibit during and after major changes in habitat is difficult to ascertain.

## CHAPTER V

# HOME RANGE AND HUNTING HABITAT UTILIZATION OF BREEDING MALE RICHARDSON'S MERLINS IN SOUTHEASTERN MONTANA

### Introduction

The Richardson's Merlin (Falco columbarius richardsonii) is primarily an inhabitant of sparsely-treed prairie and grassland habitats in the northern Great Plains. Nesting pairs in the Canadian prairies use small groves of deciduous trees along rivers (Bent 1938) and shelterbelts (Hodson 1976) located adjacent to grasslands. In the western United States, Richardson's Merlins nest in deciduous riparian communities (Call 1978) and in coniferous stands in close proximity to grasslands (Ellis 1976, Postovit 1979).

Use of grassland habitats by hunting Richardson's Merlins has been indicated by results of food habits studies (Bent 1938, Fox 1964, Hodson 1978). Detailed information on Merlin home range and habitat utilization is lacking in the literature. Such information will be essential if land managers are to successfully manage Merlins and their habitat. This paper describes home ranges and habitat use of three breeding male Richardson's Merlins in southeastern Montana.

## Study Area

Data on home range and habitat utilization were collected on a 39,448 ha area in southeastern Montana. The study area consisted largely of sagebrush/grassland prairie. Buttes and rolling hills, dominated by stands of ponderosa pine (Pinus ponderosa), were a major physiographic feature of the area. Prairie habitat was dominated by shrubs such as big sagebrush (Artemisia tridentata) and silver sagebrush (A. cana), and grasses including western wheatgrass (Agropyron smithii), blue grama (Bouteloua gracilis), prairie junegrass (Koeleria cristata), and needle-and-threadgrass (Stipa comata). Agriculture was the dominant human activity in the study area, and wheat, oats, barley, and hay were primary crops. Livestock grazing occurred in forest and prairie habitats on and adjacent to the study area.

## Methods

Adult male Merlins were captured near their nest sites. A dho gazza trapping device, modified from that described by Beebe and Webster (1964), utilized a permanently crippled Great Horned Owl (Bubo virginianus) to lure the Merlins into mist nests. After capture, Merlins were restrained in a stocking while the transmitters were attached.

Merlins were fitted with SM-1 transmitters manufactured by the



AVM Instrument Company. Each transmitter package weighed approximately 7 g. Transmitters were attached ventrally to the proximal end of the shaft of the central tail feather by two strands of monofilament embedded in the transmitter package. Two additional monofilament strands stabilized the antenna on the feather at intervals of approximately 2 and 4 cm from the transmitter package. All monofilament strands were secured by two square knots and epoxy glue.

The birds' movements were monitored for five days (eight hour periods) and during portions (a minimum of four hours) of 12 additional days. One stationary monitoring station and a mobile unit were used to triangulate locations. Locations of each bird were monitored at intervals of 15 minutes, and time, location, and azimuth were recorded for each monitoring effort. Bearings were later plotted on USGS topographic maps (scale 67.4 mm = 1.61 km). Home range of each male Merlin was calculated by use of a planimeter and delineated by the minimum home range method (Mohr 1947).

Habitat types within each male Merlin's home range were delineated on the basis of physiognomic features and mapped on USGS topographic maps (scale 67.4 mm = 1.61 km). Area and percentage of each habitat type were calculated within each home range. Pooled habitat use patterns for radio-tagged Merlins were evaluated with contingency tables, and numbers of observations in the various habitat types were compared to expected numbers by chi-square analysis (Neu et al. 1974).

## Results

### Home Range

Home ranges of the three male Merlins ranged from approximately 13 to 28 km<sup>2</sup> and were elongated in shape (Figure 2). The home range of one male Merlin overlapped home ranges of the other two, but no other overlaps were noted. Home ranges overlapped very little in the vicinity of the nest locations, but they overlapped substantially in hunting areas. The maximum distance that each male traveled from its nest was approximately 8 to 9 km.

### Habitat Utilization

Home ranges of the three male Merlins encompassed five physiognomic habitat types (Figure 2). The ponderosa pine habitat type dominated the sideslopes of the buttes, and consisted of mixed age and density classes. The grassland habitat type occurred on the lowlands surrounding the buttes, and was characterized by the presence of prairie grasses such as western wheatgrass, blue grama, prairie junegrass, needle-and-threadgrass, and a variety of other species. Big sagebrush was the dominant vegetation in the sagebrush habitat. The prairie riparian habitat type was characterized by dominant shrubs such as silver sagebrush and Wood's rose (Rosa woodsii) which grew along the banks of ephemeral streams. The

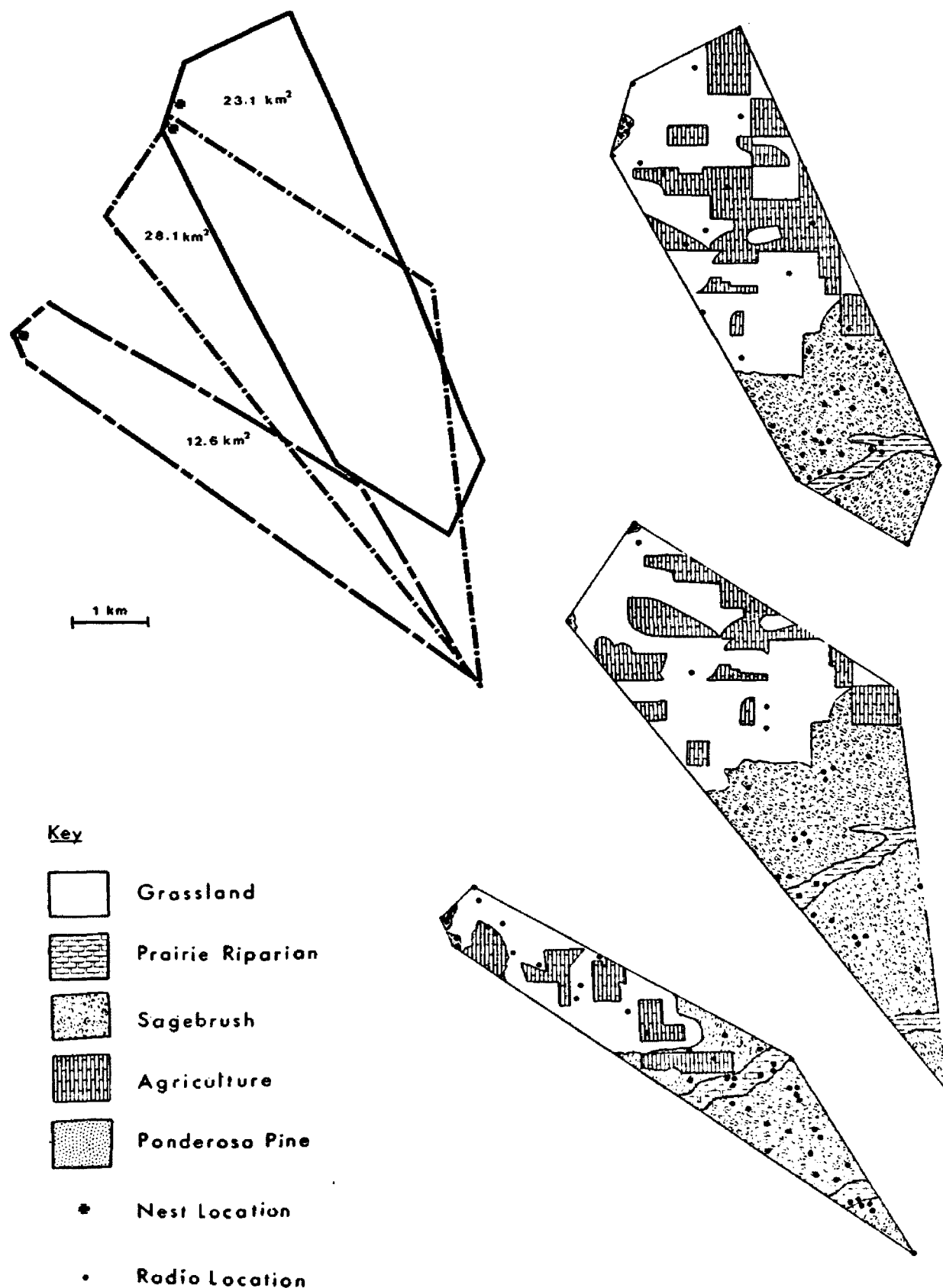


Figure 2. Home ranges, habitat types, and radio locations of three breeding male Richardson's Merlins in southeastern Montana.

agriculture habitat type consisted of grain, fallow, and hay fields.

Sagebrush, prairie riparian, and ponderosa pine habitat types were used significantly ( $P \leq 0.05$ ) more than expected based on proportionate availability of these habitats (Table 4). Grassland and agriculture habitat types were utilized less ( $P \leq 0.05$ ) than expected.

### Discussion

Few comparative data on home range sizes or foraging distances of breeding Merlins are available. Home ranges and maximum distances traveled from nests by the three Montana Merlins were large in comparison to preliminary results of a telemetry study of two breeding Merlins (F. c. aesalon) in Great Britain (Bibby, pers. comm.). The British Merlins' home ranges encompassed 5 and 6 km<sup>2</sup>, and the birds traveled maximum distances of 2 to 3 km, respectively. Factors involved in the differences between the results of this study and the British study may have included differences in habitat within home ranges, terrain, prey availability and abundance, or some combination of these factors.

Results of this study indicated a high degree of use of sagebrush habitat by breeding male Richardson's Merlins. Indeed, approximately 52% of all observed radio locations of the three males occurred in sagebrush habitat.

Locations of the three radio-tagged male Merlins in grassland habitat occurred significantly ( $P \leq 0.05$ ) less than expected.

Table 4. Radio locations of three breeding male Richardson's Merlins in five habitat types in southeastern Montana.

Habitat Type	Area (ha)	Proportion of total	Observed # of locations	Expected # of locations	Habitat <sub>1</sub> selection	Proportion observed in each habitat type and confidence interval
Sagebrush	2770	43.4%	76	61	+	0.54 ± 0.11
Grassland	2169	34.0%	22	48	-	0.16 ± 0.08
Agriculture	1182	18.5%	12	26	-	0.08 ± 0.06
Prairie						
Riparian	209	3.3%	14	5	+	0.10 ± 0.07
Ponderosa Pine	<u>51</u>	0.8%	<u>17</u>	<u>1</u>	+	0.12 ± 0.07
Total	6381		141	141		

<sup>1</sup> + denotes significantly greater ( $P \leq 0.05$ ) use than expected.  
 - denotes significantly less ( $P \leq 0.05$ ) use than expected.

However, food habits of breeding Merlins in southeastern Montana indicated that these birds preyed heavily on birds typically associated with grassland habitats, and similar results have been reported by Fox (1964) and Hodson (1978). The importance of the grassland habitat type in this study may have been under-represented because hunting perches were lacking. As a result, grassland habitat may be important even though the Merlins spent relatively little time perched there.

Apparent avoidance of agricultural habitat might have been influenced by a lack of perching sites or by lower habitat diversity and a corresponding lower diversity of potential prey species. Habitat diversity and greater corresponding prey species diversity in the prairie riparian habitat type may have caused greater observed use of this habitat than might be expected on the basis of the habitat's proportion to the Merlins' home ranges.

Locations of the male Merlins in the ponderosa pine habitat type may have occurred with greater frequency than expected due to the males' habit of spending a considerable amount of time at or near their nest sites between hunting trips. Although a study of food habits of this Merlin population indicated that about 7% of the prey was composed of forest avifauna, observations in the nesting territories suggested that these birds were taken largely by female Merlins.

Although the sample size of Merlins in this telemetry study was small, the results provided some useful information for habitat

management on the study area. Merlins relied heavily on the diversity of habitat and the abundant avifauna of sagebrush and prairie habitats. Management activities that would maintain or increase the diversity of these habitats would be beneficial to both the Merlins and their prey. The low use of agricultural land by male Merlins indicated that such areas provided low quality hunting habitat for them. Conversion of prairie/grassland habitat to agricultural cropland would reduce the diversity of Merlin hunting habitat. The forest habitat provided nesting and hunting habitat, as well as perching and night roosting sites. As a result, efforts to manage Merlin habitat in this area should stress the importance of preservation of ponderosa pine habitats and the adjacent sagebrush/grassland habitats in the face of increasing conversion to agricultural cropland.

## CHAPTER VI

### EGGSHELL QUALITY AND ORGANOCHLORINE RESIDUES IN EGGS OF RICHARDSON'S MERLINS IN SOUTHEASTERN MONTANA

Reductions in raptor eggshell weights and eggshell thickness indices have been associated with accumulations of organochlorine residues, particularly dichlorodiphenyldichloroethylene (DDE) in breeding adults (Newton 1979). Organochlorine pesticides became available for public use in the United States in 1945 (USDI Fish and Wildlife Service 1966). Decreases in eggshell thickness accompanied by population declines in Bald Eagles (Haliaeetus leucocephalus), Ospreys (Pandion haliaetus) and Peregrine Falcons (Falco peregrinus) began in 1947 (Hickey and Anderson 1968).

Evidence of organochlorine pesticide contamination and its effects on Merlins (Falco columbarius) in Great Britain were presented by Ratcliffe (1970), Newton (1973), Newton et al. (1978), and Newton et al. (1981). In North America, the effects of chlorinated hydrocarbons on Merlin reproductive success have been studied mainly in Canada (Fox 1971, Temple 1972b, Fyfe et al. 1976, Hodson 1976, Fox and Donald 1980). In the United States, published information is limited to analysis of residues in three eggs that failed to hatch at a Montana nest (Ellis 1976).

This paper describes eggshell weights and thickness indices and organochlorine residue concentrations in Richardson's Merlin (F.



c. richardsonii) eggs collected in southeastern Montana. Results are compared with similar measurements of pre-pesticide era (pre-1946) Merlin eggshells collected at various locations in the northern Great Plains. Potential effects of declining eggshell quality and pesticide contamination on reproduction of the Montana population are discussed.

### Study Area

The study area encompassed 39,448 ha in southeastern Montana. Habitat used by breeding Merlins consisted of hills and sandstone buttes ranging to approximately 300 m above the adjacent prairies and grasslands. Vegetative cover on the area was composed of approximately 27% forest cover and 67% grassland. The dominant forest species was ponderosa pine (Pinus ponderosa), although scattered stands of aspen (Populus tremuloides), box elder (Acer negundo) and green ash (Fraxinus pennsylvanica) grew in more mesic sites. Principal grassland species were big sagebrush (Artemisia tridentata), silver sagebrush (A. cana), western snowberry (Symphoricarpos albus), western wheatgrass (Agropyron smithii), blue grama (Bouteloua gracilis), prairie junegrass (Koeleria cristata), and needle-and-threadgrass (Stipa comata).

## Methods

During 1979 through 1981, intact Merlin eggs that failed to hatch were collected for analyses of eggshell quality. Contents of eggshells were removed through a hole  $\leq 3$  mm in diameter, and eggshells were washed and air-dried for at least 90 days. Merlin eggshells maintained by various natural history museums were used as a control sample for comparison of eggshell quality with eggs collected on the study area. To avoid potential biases caused by natural differences in eggshell measurements among subspecies, only egg sets collected within the breeding range of Richardson's Merlins were included in the control sample (Temple 1972a). Length and breadth of each eggshell were measured to 0.01 mm and each eggshell was weighed to the nearest 0.001 g. Eggshell thickness indices were calculated by the formula  $w/l \times b$ ; where  $w$  = weight (mg);  $l$  = length (mm), and  $b$  = breadth (mm) (Ratcliffe 1967).

Differences between mean eggshell weights and eggshell thickness indices of the Montana sample and the pre-1946 sample were compared with student t-tests (Steel and Torrie 1980). Results were considered significant at  $\alpha \leq 0.01$ .

Four Merlin eggs collected from four different clutches were analyzed for concentrations of organochlorines. After the eggs were collected, they were wrapped in aluminum foil, frozen, and shipped to Patuxent Wildlife Research Center for analyses. Contents were removed from eggshells and analyzed for DDE, dichlorodiphenyldi-

chloroethane (DDD), dichlorodiphenyltrichloroethane (DDT), dieldrin, heptachlor epoxide, oxychlordane, cis-chlordane, trans-chlordane, cis-nonachlor, endrin, toxaphene, and poly-chlorinated biphenyls (PCB). Analytical methodology followed that described by Cromartie et al. (1975).

## Results

Eighteen intact Richardson's Merlin eggs were collected in southeastern Montana during the study. Weights of these eggshells ranged from 1440 to 1570 mg ( $\bar{x} = 1468$ , S.D. = 34), compared to a range of 1326 to 1870 mg ( $\bar{x} = 1677$ , S.D. = 127) for 71 pre-1946 Merlin eggshells. Average weight of the Montana eggshells was 12% lower ( $t = 6.8$ ,  $P \leq 0.01$ ) than the average weight of the pre-pesticide eggshells.

Eggshell thickness indices for the Montana Merlin eggshells ranged from 1.02 to 1.21 ( $\bar{x} = 1.07$ , S.D. = 0.04) and were 20% lower ( $t = 14.3$ ,  $P \leq 0.01$ ) than the pre-1946 thickness indices, which ranged from 1.20 to 1.54 ( $\bar{x} = 1.33$ , S.D. = 0.07).

Residues of seven organochlorine compounds were detected in the contents of Merlin eggs analyzed for pesticide contamination (Table 5). Residue concentrations of DDE ranged from 1.1 to 9.6 ppm (corrected wet weight), and were detected in all four eggs. Dieldrin, heptachlor epoxide, oxychlordane, cis-chlordane, trans-chlordane and PCB residues were also detected in some samples.

Table 5. Organochlorine residues in four Richardson's Merlin eggs collected in southeastern Montana between 1978 and 1981.

Compound	<u>Concentration (ppm corected wet weight)</u>			
	Sample No.			
	1	2	3	4
p,p <sup>1</sup> - DDE	9.6	8.7	7.2	1.1
Dieldrin	0.23	0.23	0.54	---
Heptachlor epoxide	0.23	0.35	0.24	---
Oxychlordane	0.23	0.18	0.10	---
<u>cis</u> - Chlordane	---	0.16	---	---
<u>trans</u> - Chlordane	0.08	0.27	---	---
Est. <sup>2</sup> PCB	0.34	0.89	---	---

<sup>1</sup> p,p = para, para.

<sup>2</sup> Est. = Estimated residue level.

Other organochlorine compounds that were not detected included DDD, DDT, cis-nonachlor, endrin, and toxaphene.

### Discussion

The significant decrease in eggshell weight (12%) from pre-1946 levels is similar to results of an eggshell thinning study by Ratcliffe (1970). Mean weights in that study were 1.6 g for eggshells collected from 1901-46 and 1.4 g for eggshells collected from 1947-69, which represented an 11% decrease. A 23% decrease in eggshell weights of Merlin eggshells collected in Canada from 1950-69, as compared with a sample collected from 1930-49, was documented by Fox (1971).

Several studies in Great Britain and North America have documented significant decreases in eggshell thickness indices of eggshells collected more recently compared to pre-pesticide era eggshells. Ratcliffe (1970) and Newton (1973) reported a 13% decline in eggshell thickness indices of post-pesticide era eggshells from levels noted in pre-pesticide eggshells. In more recent British studies, Newton et al. (1978) and Newton et al. (1981) documented decreases in thickness indices of 22% in Northumberland and 21% in the Peak District. A 9% decrease in thickness indices in Merlin eggshells from eastern Canada was reported by Temple (1972b). A study in Alberta (Fox and Donald 1980) revealed declines of 10% in eggshell thickness indices from pre-pesticide levels for samples containing low levels of organochlorines and 25% in indices of

samples with high levels. The 20% decrease reported for the Montana Merlins is within the upper range of the results of these studies.

It is impossible to precisely identify the source of the organochlorine compounds found in Merlin eggs in southeastern Montana. Dieldrin and DDT were used in Montana in the 1960's and early 1970's, and heptachlor, endrin, lindane, and toxaphene are currently registered for application in the state (McOmber, pers. comm.). Merlins that breed in Montana may also accumulate organochlorine residues by consuming contaminated prey along migratory routes or in over-wintering areas. Leg bands from Merlins banded in Alberta have been recovered as far south as Mexico and Costa Rica (Banasch, pers. comm.). Recent research by Henny et al. (1982) indicated that Peregrine Falcons may be accumulating pesticide residues on wintering grounds in Latin America. Regardless of the source of the organochlorines, the presence of seven of these compounds in Merlin eggs from southeastern Montana indicates that organochlorine contamination may be contributing to lowered eggshell quality in this population.

The DDE residues in the four eggs analyzed are lower than peak concentrations previously reported for Merlin eggs. Ratcliffe (1970) reported DDE concentrations as high as 19.8 ppm wet weight in Merlin eggs collected in Britain, and concentrations of DDE averaged 9.4 ppm wet weight in three eggs collected in central Montana (Ellis 1976). The concentrations found in this study may be high enough to affect the reproductive success of this population. Fyfe et al.

(1976) reported that a DDE concentration of 6 ppm wet weight (assuming 6% lipid) was generally associated with decreased production of young Merlins.

Dieldrin has also been implicated as a possible cause of eggshell thinning (Ratcliffe 1970). Sub-lethal levels of dieldrin consumed by Prairie Falcons (Falco mexicanus) have been correlated with reductions in eggshell thickness indices (Enderson and Berger 1970). Greater toxicity has been reported for birds with dieldrin residues than birds with residues of DDT or its metabolites (Fyfe et al. 1969).

Heptachlor epoxide residues have been found in eggs and body tissues of Merlins in Great Britain and North America (Fyfe et al. 1976, Ratcliffe 1970, Henny et al. 1976, Hodson 1976, Fox and Donald 1980). Heptachlor epoxide, like dieldrin, has been reported as being highly toxic (Fyfe et al. 1969). Heptachlor epoxide concentrations in a dead migrant Merlin were at levels high enough to be suspected as the cause of death (Henny et al. 1976). Blus et al. (1983) reported potentially lethal levels of heptachlor epoxide in carcasses of two Red-shouldered Hawks (Buteo lineatus) and one Great Horned Owl (Bubo virginianus).

Chlordane has recently been reported as the primary cause of death in three cases involving mortality of Red-shouldered Hawks and Great Horned Owls (Blus et al. 1983). Although the authors noted that chlordane is routinely detected in environmental samples, they noted that toxicity could probably occur with the accumulation of hazardous levels of the compound.

Residual levels of PCB have been detected in most recent studies of pesticide contamination in Merlins (Ratcliffe 1970, Newton 1973, Fyfe et al. 1976, Henny et al. 1976, Newton et al. 1978, Fox and Donald 1980, Newton et al. 1981), and may have contributed to declines in eggshell quality.

The decline in Merlin eggshell quality and the presence of six organochlorine compounds in Merlin eggs in southeastern Montana is an indication that the reproductive capacity of this population of Merlins might be adversely affected. Although the present reproductive success of this population is comparable to or somewhat higher than that of Merlin populations elsewhere, the decline in eggshell quality since 1946 is a warning that this population may produce fewer numbers of young in the future due to eggs failing to hatch. Hence, eggshell quality, organochlorine contamination, and reproductive success of this population should be closely monitored in the future to enable managers to identify downward trends in the reproductive capacity of Merlins.



## CHAPTER VII.

### MANAGEMENT RECOMMENDATIONS

Since Olendorff and Stoddart's (1974) review of raptor management possibilities on western grasslands, interest in the management of raptors and their management has greatly increased. Four hundred and thirty-five titles on these subjects were added to the literature base during the period of 1973-1980 was reported by Olendorff et al. (1980). To date, however, very little literature exists on the management of Merlins and their habitat. This study provides managers with basic information on ecology, reproductive parameters, food habits, habitat utilization, and potential limiting factors of Richardson's Merlins.

The overall goal of Merlin management on the study area should be maintenance of a viable population of Merlins and the perpetuation of essential habitat features. Management activities aimed at achieving of this goal involve the following: 1) population and pesticide monitoring; 2) management and/or manipulation of habitat; 3) management of human activities, and 4) additional studies.

#### Population and Pesticide Monitoring

Management activities for Merlins on the study area should include a periodic population monitoring program conducted at

intervals of no more than five years. Field surveys of known breeding areas should be conducted, and the reproductive success should be evaluated using methods similar to those used in this study. Consistency in methodology will allow comparison of results, and will also reflect changes in local population levels or reproduction (i.e., egg production, egg or nestling mortality, or fledging success). If serious problems are detected, monitoring programs should continue in subsequent years. Periodic monitoring of eggshell quality and pesticide residue levels in eggs and prey species at intervals of five years is also recommended. If problems related to eggshell quality are documented, additional monitoring in subsequent years should be undertaken. Methods of arresting downward trends in population levels and eggshell quality should then be thoroughly examined.

### Management or Manipulation of Habitat

#### Nesting Habitat

Nesting habitat used by breeding Merlins on the study area consisted primarily of mixed-age ponderosa pine stands of low-to-moderate density. These stands were located almost exclusively on the sideslopes of buttes and hills, and they were generally dominated by a few pines of greater age, diameter, and height. Merlins selected old nests of Black-billed Magpies located in these trees.

Canopy-covered nests located less than 2 m from the top of the tree were favored by breeding Merlins (Becker, unpubl. data).

Availability of suitable nesting sites for Merlins was heavily dependent on the presence of unused Black-billed Magpie nests. Any large local decline in Black-billed Magpies would likely result in a subsequent loss of nesting sites for Merlins and an associated decline in the numbers of breeding pairs of Merlins on the study area. Such a loss of nest sites could be compensated by development of artificial nests or by moving Black-billed Magpie nests from other areas.

### Hunting Habitat

Approximately 70% of the radio-locations were recorded in sagebrush/grassland habitat types. Analysis of food habits indicated that prairie birds were an important component of the Merlin's diet. These findings indicated that sagebrush and grassland habitats were extremely important for providing an adequate prey base to sustain the Merlin population. Cultivation of portions of these habitats would lower prey densities, and thus lower the carrying capacity of breeding Merlins.

Livestock grazing in Merlin hunting habitat would benefit avian species that favor open habitats (i.e. Horned Larks) while densities of species generally associated with denser vegetative cover (i.e. Western Meadowlarks) would decline if cover were severely reduced (Ryder 1980). Hodson (1978) reported that grazed grasslands may

have benefited hunting Merlins because of reduced hiding cover for avian prey. This situation probably also existed on the Montana study area. Because Horned Larks, Lark Buntings, and Vesper Sparrows comprised over half of all identified prey, these species could be considered key prey species for Merlins on the study area.

A combination of low-to-moderate grazing intensities on sagebrush and grassland habitats on and adjacent to the study area probably created a diverse mosaic of favorable habitats for the three major prey species as well as others utilized by the Merlins.

### Management of Human Activities

Timber management, minerals and energy exploration and development, agriculture, range management, and recreation were the major human activities on and adjacent to the study area. Each of these was evaluated for their potential effects on breeding Merlins and the potential for minimizing the adverse effects.

#### Timber Management

Timber management activities include timber sale preparation, construction of access roads, timber harvest, post-and-pole harvest, slash disposal, thinning, and prescribed burning. These activities, if undertaken in the sideslope ponderosa pine stands on the study area, could result in adverse impacts on breeding Merlins including

loss of nesting habitat or short-term disruption of breeding activities. Because many timber management activities occur during spring and summer months, the potential for conflict is high. During late summer and autumn months, the potential for conflict is negligible.

### Mineral and Energy Exploration and Development

In recent years, southeastern Montana has been a center of activity for exploration and development activities for coal, oil, natural gas, bentonite, and uranium. These activities will probably continue to occur in the future. Increased exploration and development activities on the study area will result in conflicts with Merlins. These conflicts may occur in the form of lowered reproductive success due to disturbance of nesting pairs or loss of important nesting or hunting habitat.

### Agriculture

Agriculture, specifically cultivation of cereal grain crops, could have a detrimental effect on breeding Merlins and population levels if a large percentage of native sagebrush/grassland is converted to farmland. Prey densities, specifically grassland birds, might then decline to levels unable to support a viable population of Merlins. More intensive farming could also be detrimental to Merlin populations through use of chemical compounds, particularly organochlorine

insecticides or seed treatments, by causing a reduction in eggshell quality and a resulting decrease in reproductive success.

### Range Management

Range management activities generally require varying degrees on-site activity. Checks of livestock, routine repair of fences or well equipment, and utilization studies are short-term activities. Impoundment construction, well-drilling, and fence-building are longer in duration. These activities may require some minor alteration of scheduling to minimize disturbance of breeding Merlins during March through July. Intensive grazing or over-stocking may reduce vegetative diversity of sagebrush/grassland habitats, and thus Merlin prey diversity may decline.

### Recreation

Recreation activities on the study area include dispersed recreation (i.e., hunting, snowmobiling, etc.) or developed recreation (i.e., use of developed recreation facilities such as campgrounds and picnic grounds). Dispersed recreation activities are generally temporary and seasonal, and thus they would probably not be of great significance as a disturbance factor for Merlins. Placement of developed recreation facilities, because of their permanent nature and their tendency to be a gathering place for people, could pose a threat

to local nesting pairs of Merlins. Thus, known Merlin breeding habitat should be avoided in campground or picnic ground siting.

### Guidelines for Management of Human Activities

The following guidelines for management of human activities were designed to minimize disturbance of breeding Merlins and loss of habitat. These guidelines should be consulted and used on a case-by-case basis by managers evaluating alternative actions when conflicts arise between Merlins and the human activities discussed above.

- 1) Limit human activity, especially long-lasting or noisy activities in sideslope ponderosa pine habitat where breeding Merlins are observed or in which breeding Merlins have been observed in previous years.
- 2) Schedule activities outside of the period of 1 March through 20 July to avoid undue disturbance of Merlin breeding activities.
- 3) When intensive human activity in sideslope ponderosa pine habitat cannot be avoided or scheduled outside the period of 1 March through 20 July, field reconnaissance of the area should be conducted by a wildlife biologist to determine if breeding Merlins or active nests are located in the vicinity. If either is present, possible conflicts and management options should be discussed. Reconnaissance

should be conducted either during courtship activities (20 March through 15 May) or during the nestling period (20 May through 20 July).

- 4) In areas in which conflicts between Merlins and human activities may occur, a 400 m zone of no disturbance surrounding known or suspected nest sites in all directions should be established. Size of the zone of no disturbance was based on the average size of areas defended by territorial defensive adult Merlins. Restriction of activity within the 400 m zone should remain in effect from 1 March to 20 July. Casual short-term activities such as moving livestock, fence repair, passage through the area, etc. should not be regarded as serious disturbances.
- 5) Grassland and sagebrush-dominated grassland habitats should be maintained to the greatest degree possible.
- 6) Rest-rotation grazing plans or similar alternatives that maintain a mosaic of areas of various livestock grazing intensities should be encouraged. Such systems should provide diversity of habitats for Merlin prey species (i.e., grassland birds).
7. Any conversion of sagebrush-dominated habitat to grassland should be accomplished in a manner that leaves blocks of sagebrush habitat intact to insure habitat diversity.
- 8) Organochlorine compounds should not be used on or adjacent to the study area.



- 9) Roads, recreation sites, or industrial facilities should be constructed only after a thorough review of the location, timing of use of the facility, and possible impacts on breeding Merlins and their habitat. Activities associated with planned siting should be subject to guidelines on location, scheduling, and zones of no disturbance.
- 10) Nest locations should not be disclosed except for legitimate research or management needs.

#### Recommendations for Additional Studies

In addition to periodic monitoring, two additional management-oriented studies are recommended. A stronger information base for use in Merlin habitat management and management of disturbance as it applies to Merlins could be gained from the following studies.

- 1) An expanded radio telemetry study to more thoroughly document home range sizes and hunting habitat utilization could provide managers with specific information on spatial and habitat requirements of breeding pairs of Merlins during different stages of the breeding cycle.
- 2) A study aimed at accurately assessing the reactions of Merlins to human disturbances could allow managers to refine the basic management guidelines outlined. A study of the effects of controlled disturbance on breeding Merlins such as that conducted by White et al. (1979) on

Ferruginous Hawks would provide valuable information on Merlins' reactions to gunfire, motors, vehicles, human approach, etc. Studies of physiological reactions such as changes in heart rate and respiration during disturbances (Busch 1977) could provide valuable information on the effects of human activities on breeding Merlins.

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